

WHAT IS CLAIMED IS:

1 1. A drilling system for drilling a wellbore, comprising
2 (a) a drill string having a drill bit at an end thereof;
3 (b) a source supplying drilling fluid under pressure into the drill string (a
4 "supply fluid"), the drilling fluid returning uphole via an annulus around the drill
5 string (a "return fluid");
6 (c) a modular tool in communication with the return fluid for reducing
7 pressure in the wellbore downhole of the modular tool, said modular tool having
8 at least one interchangeable modular unit;
9 (d) an active pressure differential device ("APD Device") associated
10 with the modular tool to create a pressure drop across said APD Device to
11 reduce ; and
12 (e) a drive assembly coupled to said APD Device for energizing said
13 APD Device.

1 2. The system according to claim (1) wherein said modular unit is provided
2 as a plurality of modular units, each of which are interchangeable with the other
3 and each of which has a substantially different value for a selected operating
4 parameter.

1 3. The system according to claim (1) wherein said APD Device is said

2 modular unit.

1 4. The system according to claim (3) further comprising a plurality of said
2 modular units, each of said modular units being configured to have a
3 substantially different value for a selected operating parameter.

1 5. The system according to claim (4) wherein said selected operating
2 parameter includes (i) pressure differential in the return fluid; (ii) rotation speed;
3 (iii) flow rate; and (iv) torque.

1 6. The system according to claim (1) wherein said drive assembly is said
2 modular unit.

1 7. The system according to claim (6) further comprising a plurality of said
2 modular units, each of said modular units being configured to have a
3 substantially different value for a selected operating parameter.

1 8. The system according to claim (7) wherein said selected operating
2 parameter is one of (i) differential pressure of the supply fluid; (ii) rotation speed;
3 (iii) flow rate; and (iv) torque.

1 9. The system according to claim (1) further comprising a comminution

2 device for reducing the size of particles entrained in the return fluid, said
3 comminution device being said modular unit.

1 10. The system according to claim (1) further comprising a high-pressure seal
2 for controlling the leaking of pressurized drilling fluid from said modular tool, said
3 high-pressure seal being said modular unit.

1 11. The system according to claim (1) further comprising an annular seal for
2 directing return fluid into said modular tool, said annular seal being said modular
3 unit.

1 12. A drilling system for drilling a wellbore, comprising

2 (a) a drill string having a drill bit at an end thereof;

3 (b) a source of drilling fluid supplying drilling fluid under pressure into
4 the drill string (a "supply fluid"), the drilling fluid returning uphole via an annulus
5 around the drill string (a "return fluid");

6 (c) an active pressure differential device ("APD Device") associated
7 with the return fluid to create a pressure drop across said APD Device to reduce
8 pressure in the wellbore downhole of the APD Device;

9 (d) a drive assembly coupled to said APD Device for energizing said
10 APD Device; and

11 (e) a high-pressure seal associated with said drive assembly, said seal

12 configure to provide a controlled leakage of pressurized drilling fluid out of said
13 drive assembly.

1 13. The drilling system according to claim (12) wherein said high-pressure
2 seal is configured to operate as a radial bearing for providing lateral stability a
3 shaft associated with said drive assembly.

1 14. The drilling system according to claim (12) wherein said high-pressure
2 seal comprises a plurality of seal elements.

1 15. The drilling system according to claim (12) wherein said high-pressure
2 seal is configured to provide a leak rate of fluid for cooling and lubricating a
3 bearing.

1 16. The drilling system according to claim (12) wherein said high-pressure
2 seal comprises a concentrically arranged inner sleeve and outer sleeve, said
3 inner sleeve being fixed on a shaft assembly associated with the drive assembly
4 and said outer sleeve being fixed to a housing associated with the drive
5 assembly.

1 17. The drilling system according to claim (12) wherein said high-pressure
2 seal includes one of (i) a hardened surface, and (ii) a hardened insert to reduce

3 frictional wear.

1 18. The drilling system according to claim (12) wherein said high-pressure
2 seal is formed as a modular unit.

1 19. A method of constructing a tool for reducing pressure in the wellbore
2 downhole of the modular tool, comprising:

3 (a) providing a plurality of modular units, said modular units being
4 selected from a group consisting of: (i) an active pressure differential device
5 module (APD device module) for creating a pressure differential in a fluid
6 returning from a drill bit; (ii) a drive module for energizing the APD Device
7 module; (iii) a comminution device module for reducing the size of cutting in the
8 wellbore; (iv) an annular seal module for directing fluid into the APD Device
9 module; and (v) a high-pressure seal module for substantially sealing a
10 pressurized fluid in the drive module;

11 (b) assembling the plurality of modular units into a plurality of tool sub-
12 assemblies; and

13 (c) assembling the plurality of tool sub-assemblies into a modular tool
14 for reducing pressure in the wellbore downhole of the modular tool.

1 20. A method for drilling a wellbore, comprising

2 (a) providing a drill string having a drill bit at an end thereof;

- 3 (b) supplying drilling fluid under pressure into the drill string (a “supply
4 fluid”), the drilling fluid returning uphole via an annulus around the drill string (a
5 “return fluid”);
- 6 (c) positioning a modular tool in communication with the return fluid for
7 reducing pressure in the wellbore downhole of the modular tool, said modular
8 tool having at least one interchangeable modular unit;
- 9 (d) creating a pressure drop in the return fluid using an active pressure
10 differential device (“APD Device”) associated with the modular tool; and
- 11 (e) energizing the APD Device with a drive assembly.

1 21. The method according to claim (19) wherein said modular unit is provided
2 as a plurality of modular units, each of which are interchangeable with the other
3 and each of which has a substantially different value for a selected operating
4 parameter.

1 22. The method according to claim (19) further comprising forming the APD
2 Device as the modular unit.

1 23. The method according to claim (21) further comprising forming the APD
2 Device as a plurality of modular units, each of the modular units being configured
3 to have a substantially different value for a selected operating parameter
4 selected from one of (i) pressure differential in the return fluid; (ii) rotation speed;
5 (iii) flow rate; and (iv) torque.

1 24. The method according to claim (19) further comprising forming the drive
2 assembly as the modular unit.

1 25 The method according to claim (21) further comprising forming the
2 modular units as a plurality modular units, each of said modular units being
3 configured to have a substantially different value for a selected operating
4 parameter selected from one of (i) differential pressure of the supply fluid; (ii)
5 rotation speed; (iii) flow rate; and (iv) torque.

1 26. The method according to claim (19) wherein the modular unit is selected
2 from one of (i) a comminution device for reducing the size of particles entrained
3 in the return fluid, (ii) a high-pressure seal for minimizing the leaking of
4 pressurized drilling fluid from the modular tool, and (iii) an annular seal for
5 directing return fluid into the modular tool.

1 27 A method for drilling a wellbore, comprising
2 (a) a drill string having a drill bit at an end thereof;
3 (b) supplying drilling fluid under pressure into the drill string (a "supply
4 fluid"), the drilling fluid returning uphole via an annulus around the drill string (a
5 "return fluid");
6 (c) positioning an active pressure differential device ("APD Device") in
7 communication with the return fluid to create a pressure drop across said APD
8 Device to reduce pressure in the wellbore;

9 (d) energizing the APD Device with a drive assembly coupled to the
10 APD Device; and

11 (e) sealing the pressurized drilling fluid in the drive assembly using a
12 high-pressure seal having a pre-determined rate of leakage.

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1 28. The method according to claim (26) further comprising providing lateral
2 stability for a shaft associated with the drive assembly using the high-pressure
3 seal.

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1 29. The method according to claim (26) further comprising cooling and
2 lubricating a bearing using the drilling fluid leaked through the high-pressure
3 seal.

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1 30. The method according to claim (26) wherein the high-pressure seal
2 comprises a concentrically arranged inner sleeve and outer sleeve, the inner
3 sleeve being fixed on a shaft assembly associated with the drive assembly and
4 the outer sleeve being fixed to a housing associated with the drive assembly.